band of cells, the chorda-entoblast, entering into the formation of the entodermic wall, but resembling in character the ectodermal cells; 2°, the development of the mesoderm as a paired outgrowth from the blastopore. In part second of his paper, Hertwig reviews the published investigations on the embryology of other classes of vertebrates. He accepts the homology of the primitive streak in Amniota with the blastopore. He is fairly successful in proving the same relations of the germ-layers to exist in all vertebrates. He also discusses the various objections advanced against the *coelomtheorie*, according to which the mesoderm is an epithelial layer, bounding the body-cavity. He draws from his observations and arguments the following conclusions: 1. The mesoblast grows as a continuous mass from acknowledged epithelial layers; 2. In all vertebrates there early appears a fissure in the mesoderm, limited parietally and viscerally by epithelium, as can be especially well seen in elasmobranch embryos; 3. From this epithelium are derived true epithelial membranes in the adult, from which are developed the peritoneum, kidneys, sexual glands, etc.; 4. The primitive mode of origin of the mesoderm is probably that described by Kowalevsky and Hatschek in Amphioxus, —an invagination of an epithelial membrane (entoderm); 5. In the true vertebrates the mesoderm grows out as a solid mass, in which the fissure appears later. This must be regarded as a secondary modification, for we frequently find hollow organs making their first appearance as solid *anlagen;* e.g., the central nervous system of teleosts, many sense-organs, and most glands. These considerations lead collectively to the final conclusion that the mesodermic plates are morphologically epithelial evaginations homologous with those of the invertebrates.

CHARLES SEDGWICK MINOT.

ACOUSTIC ROTATION APPARATUS.

IN a recent number of the *Zeitschrift für instrumentenkunde*, Dr. V. Dvořák gives an account of the various forms of apparatus which have been devised to show attraction or repulsion due to sound-waves, or to gain a continuous rotation.

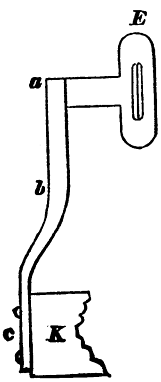


FIG. 1.

Such experiments require a good volume of sound for success. That this may be obtained, not only should the tuning-fork be in accord with the resonator-box on which it is placed (the most convenient form of sounding-body for the purpose), but also the elastic system, consisting of tuning-fork and box, should be capable of vibrating in unison with the fork and the air in the resonator. The three sounds are called the fork, the air, and the wood tone. In order to get the last, the resonator should be stuffed with cotton-wool, and a piece of cork put between the prongs of the fork; then, by rapping on the top of the fork, the whole system is vibrated very much as it would be by the up-and-down motions of the lower part of the fork when free. By cutting away the walls of the resonator to make them thinner, the system may readily be brought to the right pitch. In most of the resonators in common use the wood tone is too low, owing to the wood being already too thin.

The fork used by Dr. Dvořák was *G*, having 392 vibrations per second. It weighed 265 grams. As a resonator, an ordinary pine box was used, about 13.5 cm. long, 11 cm. broad, and 10.5 cm. high. In one side a round hole was cut, large enough to make the air tone of the right pitch. The wood was 8 mm. thick. From the top and bottom it was shaved off for the purpose explained above. The dimensions of the box were entirely accidental, but proved to be good.

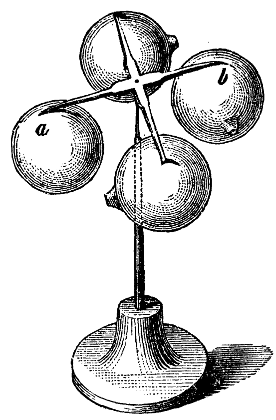


FIG. 2.

By using an electro-magnet to keep the fork in continuous vibration, the results are naturally more sure. The form of magnet which has proved satisfactory is shown in fig. 1. *E* is the magnet, with a core made of iron plates. This magnet is placed between the prongs of the fork, and is held by the wooden arm *a c*, to the lower end of which is fastened the resonator *K*. At *b* the arm is bound to a firm support, so that the system of fork and resonator is perfectly free.

The resonator-wheel (fig. 2) is the first form of rotating apparatus described. It consists, as shown in the illustration, of four glass resonators on the four arms of a wheel. For a fork of 392 vibrations, the spheres should be about 44 mm. in diameter, with openings 4 mm. across. Rotation was obtained with the fork 40 cm. away.

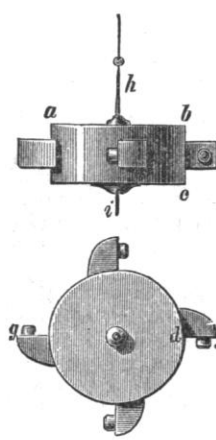


FIG. 3.

As a modification of this wheel, a rotating resonator (fig. 3) may be made of a flat cylindrical pasteboard box, having a number of side-openings, each ending in a short piece of tubing of size to make the resonator respond to the fork. When suspended by a silk thread, *h*, such a resonator

can be easily put in rotation ; *i* is a needle to rest in a hole in a piece of lead, to prevent oscillation. The dimensions given are: *a b*, 70 mm.; *b c*, 36 mm.; *d f*, 19 mm. The tubing openings were 8 mm. long and 6 mm. in diameter.

The sound-radiometer (fig. 4) is readily made. In cardboard about 8 mm. thick, holes are punched at intervals of 6 mm. with the punch of the form shown at *A*. When prepared in this way, the cardboard will be repelled if presented to the resonator with the small ends of the holes toward it, and attracted when reversed. To make these effects more marked, the punch and die shown at *B* and *C* may be

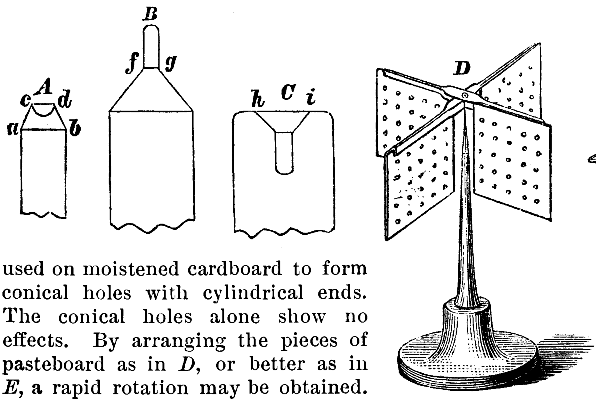


FIG. 4.

used on moistened cardboard to form conical holes with cylindrical ends. The conical holes alone show no effects. By arranging the pieces of pasteboard as in *D*, or better as in *E*, a rapid rotation may be obtained. The apparatus shown in fig. 5 is called a sound-wind-mill. A Helmholtz resonator, *a b*, is placed before the opening of the box-resonator. Out of the smaller end, *a*, a stream of air will be blown when the fork is vibrated, and its existence shown by the rotation of the windmill, *h k*. The dimensions of the Helmholtz resonator for *G* are : diameter, 80 mm. ; the opening at *b*, 16 mm. ; at *a*, 2 mm. This last is very important. It seems odd that the resonator with two openings may be replaced by such as shown at *R* with only one. The opening may face in any direction, provided the windmill is suitably placed, and still the mill will turn. When the opening is turned toward the resonator-box, the distance between the

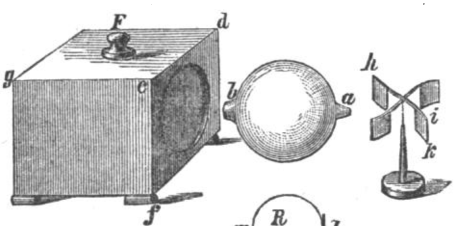


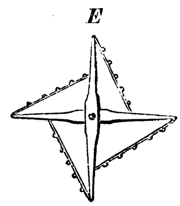
FIG. 5.

resonators may be as great as half a metre. The dimensions and form of the ball are important. A suitable one may be made by grinding off the top of a glass globe 50 mm. in diameter, and covering the opening with a very thin metal plate in which there is a hole 3.5 mm. across. The puffs of air coming from the opening *l* are vortex-rings, which may easily be shown by filling the ball with smoke.

By putting one of the wings of the sound-radiometer before the box-resonator with the larger ends of the holes facing it and at a distance of 2 cm. from it, the mill may be made to rotate by the puffs of air coming through the holes, which should be numerous.

AURORAL EXPERIMENTS IN LAPLAND.

MR. J. RAND CAPRON gives a brief account (*The observatory*, Sept.) of Professor Lemström's experiments, quite similar to that which has already appeared in SCIENCE. He thinks that Professor Lemström's conclusion, that the height of auroras "has been generally over-estimated may probably open a lively discussion, as undoubtedly his dictum will that 'measurements of an aurora on a long base must be erroneous, as the observers never see the same aurora.'" He thinks, too, that the relation Professor Lemström believes himself to have proved, between movements of atmospheric electricity and the 'variations of the magnetic elements,' may be only apparent.



Mr. Capron believes that the experiments described did "collect and make apparent to the eye a true auroral glow, its spectroscopic character being at the same time tested and defined by experienced observers." He adds, "Yet one cannot help feeling something of regret that, if only for further assurance, the wave-length of some one line seen was not (as far as we are aware) absolutely determined, on some occasions at least, and that the observations appear to rest only on a small instrument presumably without scale."

Mr. Capron's article is important mainly for calling renewed attention to the phosphorescence, or fluorescence, theory of the principal (yellow-green) line of the aurora spectrum. This theory, first proposed by Angström, was advocated in the *Philosophical magazine* for April, 1875, by Mr. Capron, who is inclined to attribute the line to phosphorescence, apparently on the following grounds: 1°. The 'phosphorescent appearance' of the aurora; 2°. The fact that phosphorescence is capable of giving quite sharply defined spectral lines, as shown by his observations with a phosphorescent vacuum tube; 3°. The fact that the auroral line belongs to 'the principal region of phosphorescent light;' 4°. 'The observed circumstance that the electric discharge has a phosphorescent after-glow.'

Mr. Capron observed, moreover, that the auroral line lies in the region of a certain bright band in the spectrum of a phosphoretted hydrogen flame, though somewhat nearer the red end of the spectrum than is